RDTR NO. 164
MARCH 1970

MK 45 AIRCRAFT PARACHUTE FLARE OPTIMIZATION PROGRAM

EVALUATION OF EXPERIMENTAL PARACHUTES AND PARACHUTE MATERIALS

FLIGHT TEST SERIES NO. 2

PREPARED BY

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ABSTRACT

This report presents the results of MK 45 Aircraft Parachute Flare Developmental Flight Tests (experimental parachutes and parachute materials) conducted at Naval Weapons Center, China Lake, California, 12 November 1969 through 11 December 1969. The basis for choice of chutes and materials for these tests was derived from RDTR #163. Data obtained from these flight tests indicate the cross type parachute using Cerex Cloth (.85 oz/sqyd) to exhibit the most advantageous characteristics for incorporation into the MK 45 APF system. The data also indicates that a strength problem exists when the same canopy material (Cerex) is used on the present MK 45 APF flat circular chute. A third system utilizing a cross parachute with a Mylar/Dacron laminate cloth was evaluated. This chute also had cloth failures from the parachute snatch loading forces.

I. INTRODUCTION

A. NAD Crane has made local studies to determine the optimum parachute configuration and material for incorporation into the MK 45 APF[1,2], RDTR #163 and RDTR #130. The three most significant factors to be considered are: average descent velocity, parachute cost, and flare stability.

B. Two different parachute configurations incorporating a new spunbonded nylon material (Cerex) were evaluated. The material used was the .85 oz/sqyd, 425 ± 70 CFM cloth.

(1) Thirty cross parachutes were constructed as follows:

FIG. 1	Do*	17.6 ft.
	Gore width	7 ft.
	Gore length	21 ft.
	Crown thickness	Single
	Shroud line length	21 ft.
	No. of shroud line/panel	4 ft.
	Shroud material	Nylon
	No. hem stitches	6-8/in
	Cotton cord in skirt	Yes

(2) Thirty flat circular parachutes were constructed similar to the present MK 45 APF flat circular chute as follows:

FIG. 2	Do	15'-9"
	No. of gores	18

* Nominal Diameter: The computed diameter of parachute canopy, which equals the diameter of a circle having the same total area as the total area of the drag-producing surface.

CROSS PARACHUTE

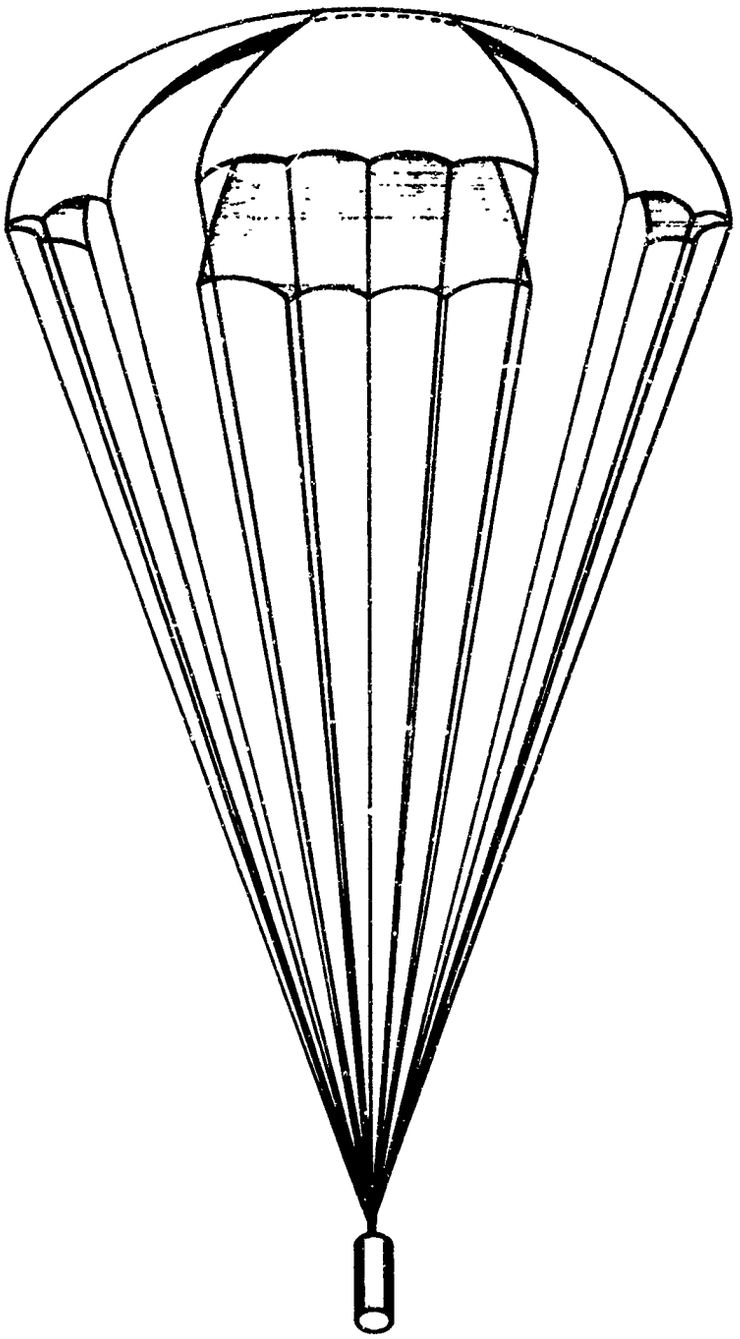

FIGURE #1

FLAT CIRCULAR PARACHUTE

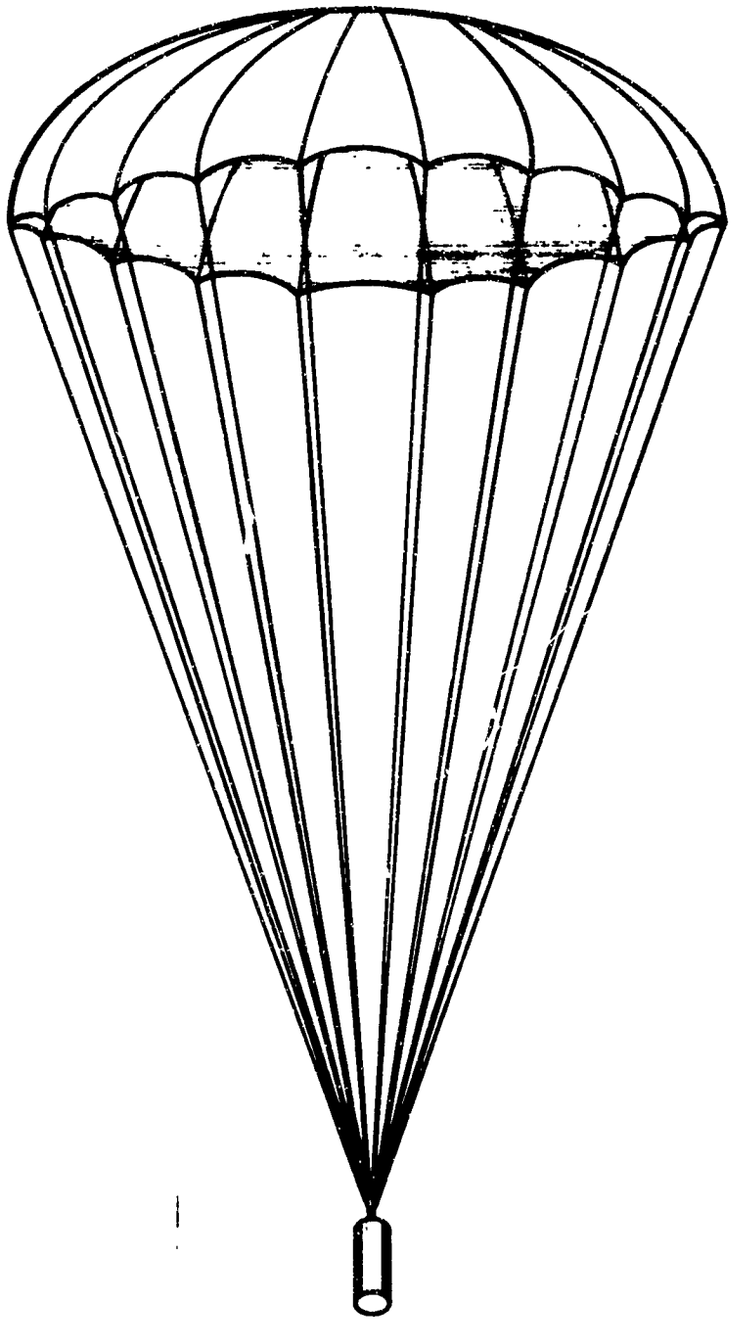

FIGURE #2

No. of shroud lines	18
Shroud line length	15'-9"
Shroud line material	nylon *
Crown tape	3/4 nylon **
Hem stitches	6-8/in ***
Hem tape	11/16 cotton
Cotton cord in skirt	Yes

Present Production MK 45 Parachute as follows:

* Cotton

** 11/16 cotton

*** 12-16/in

C. Fifty Cross parachutes incorporating a new mylar/dacron (M/D) laminate cloth were also evaluated. The material used was 1/4 mill Mylar reinforced with Dacron threads.

(1) The fifty Cross parachutes were constructed as follows:

FIG. #1	Do	16.8 ft.
	Gore width	6.33 ft.
	Gore length	20.6 ft.
	Crown thickness	Double
	Shroud line length	20.6 ft.
	Shroud line material	nylon
	No shroud line/panel	5

All 110 of these experimental parachutes were assembled into MK 45 APF's at NAD Crane.

II. TEST FLIGHTS

A total of 148 MK 45 APF's were flight tested at aircraft speeds of 200 through 450 KIAS. The 148 consisted of the 110 experimental parachutes plus 38 standard MK 45 APF's. The standard flares were launched to provide a basis for comparison.

All flight tests were conducted at Naval Weapons Center, China Lake, California. An A-4 aircraft was utilized for all tests. Fuze settings, aircraft air speed, and launch altitude varied as shown in Appendix A. The aircraft carried 20 flares mounted 4 each on 5 external Multiple Stores Bomb Racks (MSBR), and two flares were launched on each pass over the drop zone. Radar was employed to determine average flare descent velocity of the first flare of each pair released, (typical radar plots are shown in Appendix B), and 16mm photographic coverage was employed to obtain data on chute stability and any malfunctions that might arise on the second flare released. These flights extended over a period of 30 days. The results, therefore, should be considered in light of many different environmental (meteorological) conditions.

The MK 45 APF's were numbered as follows:

1. P-150 thru P-187 Std Production MK 45 APF's.
2. K-100 thru K-149 MK 45 APF's utilizing the cross parachute fabricated of Mylar/Dacron cloth.
3. K-186 thru K-217 MK 45 APF's utilizing the flat circular parachute fabricated of Cerex cloth.

4. K-218 thru K-247 MK 45 APF's utilizing the cross parachute fabricated of Cerex cloth.

Several parachutes were recovered. These were inspected and photographs were made of the damage which would have affected chute performance. These photographs appear in Appendix C. Each photograph is identified as to test number, launch speed, fuze setting, parachute ejection velocity, and parachute configuration and material.

III. CONVERSION FORMULA

Because the test flights were conducted using production MK 45 APF's as a base comparison, and because of the widely different meteorological conditions encountered over the total evaluation period, the average descent velocity of each parachute/candle system evaluated had to be converted to a nominal average descent velocity using the following formula:

$$\frac{\text{Experimental Parachute (Nom) Average Descent Velocity}}{\text{Experimental Parachute (Test) Ave. Descent Velocity}} = \frac{\text{Production MK 45 Parachute (Nom Average Descent Velocity 8 ft/sec)}}{\text{Production Mk 45 Parachute (Test) Ave. Descent Velocity}}$$

IV. AVERAGE DESCENT VELOCITY DETERMINATION

The average descent velocity was computed by using the time and distance from candle ignition to the lowest point of the candle trajectory. It should be understood that in some instances during positive descent, the parachute/candle system became buoyant and thus changed to negative descent near the end of candle burn. This negative descent was not considered in the final

determination of the average descent velocity.

V. DISCUSSION OF FLIGHT TEST RESULTS

The following specific information provides test parameters and data that was obtained from launchings of the parachute configurations listed previously.

A. Cross parachute Do = 16.8', Mylar/Dacron material (50 chutes total) - Parachutes were fabricated by G. T. Schjeldahl Co.

(1) All flares were dropped from external MSBR's mounted on an A-4 aircraft.

(2) Aircraft speed varied from 250 to 400 KIAS, and fuze settings of 500 and 1000 ft. were used.

(3) Parachute deployment velocity varied from 200 to 250 ft/sec.

(4) The following malfunctions were noted:

(a) Nine flares were lost because of a bomb rack solinoid failure. This caused the flares to drop with the entire lanyard attached.

(b) One lanyard broke at flare release from aircraft.

(c) One chute was a streamer.

(d) Twelve chutes were extensively damaged on opening, causing the flare to have faster than normal descent velocity.

(e) The remaining twenty-seven flares looked OK visually during descent; however, later inspection determined there was slight damage to some of the chutes' canopy cloth.

(f) Of the 16 production MK 45 APF's that were dropped in conjunction with the above, there were: Two duds due to rack solinoid failure, one unit had a long delay from launch to ignition (12.4 secs.), one chute was a streamer, and one lanyard broke at flare release from aircraft.

(5) The following descent velocities were obtained:

Production MK 45 Chute	Cross Chute Do = 16.8'(M/D)
Avg. Descent Velocity (ft/sec)	Avg. Descent Velocity (ft/sec)
8.5	6.7
7.0	4.7
7.3	5.5
7.4	5.3
7.6	6.9
7.9	4.2
6 | 45.7	4.5
7.61 ft/sec	2.7
	6.5
	3.3
Conversion Formula (Para. III, Page 4):	5.0
$\frac{x}{5.08} = \frac{8}{7.61}$	6.1
	4.7
	13 | 66.1
	5.08 ft/sec

Nominal average descent velocity = 5.35 ft/sec

B. Flat Circular Parachute, 15.9' diameter, Cerex cloth (30 chutes total) - parachutes were fabricated by Raven Industries.

(1) All flares were dropped from external MSBR's mounted on an A-4 aircraft.

(2) Aircraft speed varied from 200 to 450 KIAS, and fuze settings of 500 and 1000 ft. were used.

(3) Parachute deployment velocity varied from 195 to 250 ft/sec.

(4) The following malfunctions were noted:

(a) One lanyard broke at flare release from aircraft.

(b) One flare had the end cap to eject, but parachute and candle never ejected.

(c) One flare released at 350 (KIAS) with 500 ft. fuze setting, deployed chute at 195 ft/sec. The cloth on this chute tore about 1 inch above the top stitching in the hem tape, a distance of approximately 4 feet around the periphery of the chute.

(d) The remaining twenty-seven flares performed satisfactorily.

(5) The ten production MK 45 APF's dropped in conjunction with above, performed satisfactorily.

(6) The following descent velocities were obtained:

Production MK 45 Chute	Flat Circular Chute Do = 15.9' (Cerex)
Avg. Descent Velocity (ft/sec)	Avg. Descent Velocity (ft/sec)
5.9	6.5
7.1	8.7
8.6	6.7
10.5	6.9
7.0	7.2
5 | 39.1	8.2
7.82 ft/sec	8.4
	6.9
	7.8
	8.2
	8.8
	8.8
	7.7
	13 | 100.8
	8.31 ft/sec

Conversion Formula (Para III, Page 4):

$$\frac{X}{8.31} = \frac{8.0}{7.82}$$

Nominal Avg. descent velocity = 8.5 ft/sec

C. Cross Parachute, Do = 17.6', Cerex cloth (30 chutes total) - Parachutes were fabricated by Raven Industries.

(1) All flares were dropped from external MSBR's mounted on an A-4 aircraft.

(2) Aircraft speed varied from 200 to 450 (KIAS), and fuze setting of 500 and 1000 ft. were used.

(3) Parachute deployment velocity varied from 195 to 250 ft/sec.

(4) The following malfunctions were noted:

(a) One flare had the lanyard to pull out of the nicopress sleeve on flare release from aircraft.

(b) One flare released at 425 (KIAS) with 500 ft. fuze setting, deployed chute at 205 ft/sec. The cloth on this chute tore about 1/2 inch above the stitching in the hem tape, a distance of approximately 8 in. along the hem.

(c) A second flare released at 450 (KIAS) and 500 ft. fuze setting, deployed chute at 215 ft/sec. The cloth on this chute tore (as above) a distance of approximately 20 inches along the hem.

(d) The remaining twenty-seven flares performed satisfactorily.

(5) Eleven of the twelve production MK 45 APF's performed satisfactorily. The fuze on the other flare was still on safe when recovered from the range.

(6) The following descent velocities were obtained:

Production MK 45 Chute	Cross Chute, Do = 17.6' (Cerex)
Avg. Descent Velocity (ft/sec)	Avg. Descent Velocity (ft/sec)
7.0	6.6
6.8	5.7
7.7	2.9

7.4	3.6
4.5	5.1
5 33.4	3.7
6.68 ft/sec	3.5
	3.9
	2.5
	3.6
	4.5
	3.9
	4.9
	5.1
	4.7
	15 64.2
	4.28 ft/sec

Conversion Formula (Para III, page 4):

$$\frac{x}{4.28} = \frac{8}{6.68}$$

Nominal avg. descent velocity = 5.14 ft/sec

All the aforementioned flight test data are included in Appendix A.

VI. SUMMARY

A. The following resulted from the flight testing herein reported.

(1) A potential strength problem was found in the present MK 45 parachute configuration when the Cerex cloth was substituted for present woven nylon cloth. Although only one chute failure was found, it was at a deployment velocity of only 215 ft/sec. It should be noted that a 350 KIAS aircraft release and a 3.5 sec.

fuze delay would develop a 275 ft/sec parachute deployment under the same environmental conditions. No difference was found in the instability of the flare by substituting the Cerex cloth, it was still in the range of ±40-45° from vertical. This chute also had a faster corrected average descent velocity 8.5 ft/sec vs. 8 ft/sec for the production MK 45 chute.

(2) The Cross parachute fabricated of the same Cerex cloth performed very well. Slight damage (hem tears) was found on two chutes which were deployed at 205 and 215 ft/sec. This damage was very minor and it is felt that it is not a problem at present. This chute and material had very good stability ±5° from vertical axis in most cases. This chute exhibited a much slower corrected average descent velocity 5.14 ft/sec vs. 8 ft/sec for the production MK 45 chute, a 36% reduction.

(3) The Cross parachute fabricated of the Mylar/Dacron laminate material had an obvious strength problem at snatch loading, when deployment velocity was above 200 ft/sec. (It should be mentioned at this time, that unknown until after parachutes were evaluated, the cloth furnished for these parachutes was fabricated differently than cloth used in[1] RDTR #163. This fact may or may not have a bearing on the results that were obtained). If the chute was not damaged badly enough to cause it to squid, the damage did not seem to adversely affect the stability ±3°-4° from vertical axis or the descent velocity. Even though most chutes

showed some cloth damage, their corrected average descent velocity of 5.35 ft/sec was much slower than the Production MK 45 Parachute; a 33% reduction.

VII. RECOMMENDATIONS

It is recommended that a smaller cross parachute (approximately 16 ft. panel length, Do = 13-13.5 ft) fabricated of .85 oz/yd. 425 ± 70 CFM Cerex flare cloth be further evaluated. This program indicates that Cerex cloth exhibits the strength to withstand the snatch loading required for this diameter parachute. A parachute of this diameter, fabricated of Cerex cloth, should provide the same average descent velocity as the present production MK 45 APF chute, plus exhibit a sizable reduction in parachute cost and increase the flare's stability.

REFERENCES

1. Koch, Clenneth R., RDTR #163, MK 45 Aircraft Parachute Flare Optimization Program, Preliminary Evaluation of Experimental Parachutes and Parachute Materials, Flight Test Series No. 1, U. S. Naval Ammunition Depot, Crane, Indiana.

2. Koch, Clenneth R., RDTR #130, MK 24-Size Candle Parachute Destruct Configuration Optimization Program, U. S. Naval Ammunition Depot, Crane, Indiana.

ACKNOWLEDGMENT

I wish to express thanks to Lee Jameson of the G. T. Schjeldahl Company, Northfield, Minnesota, and to Gene Hanson and Dean Boettcher of Raven Industries, Sioux Falls, South Dakota, for their helpful assistance in preparing for and carrying out this development program.

APPENDIX A

SPECIAL PARACHUTE TESTS

FLARE NO.	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE)*	REMARKS
K-100	CROSS	500	400								DUD, RACK SOLENOID MALFUNCTION
K-101	"	"	"								" " "
P-150	MK-45	"	"								" " "
P-151	"	"	"								" " "
K-102	CROSS	"	"								" " "
K-103	"	"	"								" " "
K-104	"	"	"								" " "
K-105	"	"	"								" " "
K-106	"	"	"	5.2	240	7.5			242		Chute Damaged at Opening. Burned Out On Ground
K-107	"	"	"	7.2	215	7.8	8.2	242	247	C	±3° Oscillation. Candle Ascended into its Smoke the last 13 Seconds of B. T.
P-152	MK-45	"	"	6.2	225	7.2	7.8	249	253	8.5	±40° Oscillation
P-153	"	"	"	No Record	230	5.8	No Record	232	235	C	±35° Oscillation.
K-108	CROSS	"	"	7.3	215	7.8	10.3		243		Flare Separated from Chute at 60 Seconds.
K-109	"	"	"	7.2	215	8.2			175	C	Damaged Chute. Squided to Ground.
K-110	"	"	350	6.1	220	6.5	6.9	231	235	C	±2° Oscillation. Candle Ascended into its Smoke the last 37 Seconds of B. T.
K-111	"	"	"	6.4	215	6.6	7.9	226	236	6.7	±3° to ±5° Oscillation.
K-112	"	"	"	7.8	210	8.5	8.8	234	237	4.7	±4° Oscillation.
K-113	"	"	"	5.5	225	6.4	7.2	235	238	C	Damaged Chute. One Panel held by one shroud Line. Chute still had good stability.
P-154	MK-45	"	"	4.1	250	4.5	4.9	236	242	7.0	±30° Oscillation.

* C IS CAMERA COVERAGE AND NO RADAR RECORD MADE OF FLARE.

APPENDIX A

EXPERIMENTAL PARACHUTE TESTS

FLARE NO	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE.)*	REMARKS
P-155	MK-45	500	350							C	Dud. Lanyard Broke on Release from Rack.
K-114	CROSS	"	"	7.7	200	8.4	8.4	232	234	5.5	Slight Damage to Chute on Opening. Worked O.K.
K-115	"	"	300	6.3	218	6.9	7.0	242	245	C	±2° Oscillation. Chute Looked good on Film.
K-116	"	"	"	5.7	215	6.2	6.5	235	240	5.3	±4° Oscillation.
K-117	"	"	"	6.0	215	6.9	7.4	161	174	C	Fast Burning Candle ±3°-±5° Oscillation. Upward into smoke last 6 seconds. Chute looked good.
K-118	"	"	"	5.2	220	6.5	6.5	233	236	6.9	±3°-±4° Oscillation.
K-119	"	"	"	6.1	215	6.7	7.0	232	236	C	±3°-±5° Oscillation. Chute looked Good. Candle ascended into smoke last 6 seconds.
P-156	MK-45	"	"		205	6.2			239		Streamer Chute. Burned out on ground.
P-157	"	"	"	6.2	210	7.2	7.2	228	237	C	±45° Oscillation.
K-120	CROSS	"	"	6.2	210	7.6	8.1	235	239	4.2	±2°-±3° Oscillation. Candle up into smoke the last 31 seconds of B. T.
K-121	"	"	"	5.6	220					C	All 4 shroud lines tore loose from one panel at Chute opening. Streamer to ground.
K-122	"	"	"	4.5	230	5.9	6.9	226	232	4.5	±3°-±4° Oscillation.
K-123	"	"	"	5.6	220	7.2	7.2	220	234	C	±2°-±4° Oscillation. Slight Damage at Opening Candle up into smoke the last 19 seconds of B. T.
K-124	"	"	"								Dud. Solenoid Failure on Rack
K-125	"	"	"	3.9	242	6.0			120	C	Chute Badly Damaged. Squided
P-158	MK-45	"	250	7.3	200	8.6	10.0	236	239	7.3	±45° Oscillation;
P-159	"	"	"	6.5	203	7.4	7.4	236	240	C	±45° Oscillation.
K-126	CROSS	"	"	5.1	212	6.9	7.6	208	219	2.7	±3° Oscillation. Very slow descent.
K-127	"	"	"	5.4	210	6.4	6.8	225	234	C	±3° Oscillation. One Panel Damaged on Opening

* C IS CAMERA COVERAGE AND NO RADAR RECORD MADE OF FLARE.

APPENDIX A

EXPERIMENTAL PARACHUTE TESTS

FLARE NO	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE)*	REMARKS
K-128	CROSS	500	250	5.8	205	7.3	7.5	227	236	7.3	±2°-±3° Oscillation. Damaged Chute at Ejection.
K-129	"	"	"	5.8	205	6.2	7.1	222	235	C	±3° Oscillation. One Panel Damaged at Opening.
K-130	"	1000	400	9.5	205	9.9	11.3	208	223	6.5	+2°-±4° Oscillation. Damaged Panel on Opening. Candle in Smoke Last 12 sec. Before Dump. B.T. less than 3 Minutes.
K-131	"	"	"	8.6	210		9.4				
P-160	MK-45	"	"	8.3	210	8.9	10.0	229	233	7.4	±45° Oscillation.
P-161	"	"	"	9.9	205	10.9	11.1	224	228	C	±45° Oscillation.
K-132	CROSS	"	"								Dud. Solenoid Failure On Rack.
K-133	"	"	"	8.8	210	9.4	10.1	225	237	C	±2-±4° Oscillation. Two Panels Damaged at Ejection
K-134	"	"	350	8.3	210	9.5	10.4	229	239	3.5	±2-±4° Oscillation.
K-135	"	"	"	9.7	205	10.2	10.9	175	184	C	±2°-±3°. 1 Panel Damaged. Candle up into Smoke last 9 sec of B.T. Fast Burning Candle
K-136	"	"	"		205	10.5			215		Damaged Chute. 150 seconds to impact.
K-137	"	"	"							C	Dud. Lanyard Broke at Release.
P-162	MK-45	"	"	9.9	205	10.2	12.6		243	7.6	±45° Oscillation. Dropped too low ground Impact at 210 seconds.
P-163	"	"	"	9.9	205	10.2	11.9		245	C	Dropped too low. Ground impact at 82 sec. May have been Chute damage. Chute Burned.
K-138	CROSS	"	300	8.9	205	9.5	10.0	167	176	5.0	±2°-±4° Oscillation. Fast Burning Candle.
K-139	"	"	"	10.1	205	11.2	11.0	168	183	C	±2°-±3° Oscillation. Damaged Panel on Opening Candle up into Smoke Last 8 seconds of B.T.
K-140	"	"	"	8.7	205	9.4	10.1	168	186	6.1	±2°-±4° Oscillation - Good Stability
K-141	"	"	"	10.4	205	11.0	11.6	180	181	C	±2°-±3° Oscillation. Damaged Panel on Opening Candle up into smoke last 6 sec. before Dump Candle Tore Off Chute on Opening. 28 Sec to Impact. Burned out on Ground.
K-142	"	"	"	8.3	205	8.5					

* C IS CAMERA COVERAGE AND NO RADAR RECORD MADE OF FLARE

EXPERIMENTAL PARACHUTE TESTS

APPENDIX A

FLARE NO	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE)*	REMARKS
K-143	CROSS	1000	300	10.4	205	11.4	11.4	171	182	C	Fast Burning Candle Damaged Panel at Opening
P-164	MK-45	"	"	9.2	205	10.0	10.2	242	244	7.9	±45° Oscillation.
P-165	"	"	"	7.6	205	8.5	8.8	224	231	C	±45° Oscillation.
K-144	CROSS	"	250	10.9	200	11.5	12.2	170	181	4.7	±2°-±4° Oscillation. Fast Burning Candle. Damaged Panel at opening.
K-145	"	"	"	8.4	200	9.2	9.3	167	179	C	±2°-±3° Oscillation. Fast Burning Candle.
K-146	"	"	"	10.0	200	10.5	11.7	167	178	7.6	All Shroud Lines Came off one gore. This Caused Faster Descent Rate.
K-147	"	"	"	10.5	200	11.2	11.5	162	174	C	1 Shroud Line Tore Back from Hem Edge of Gore Approx. 3 ft.
K-148	"	"	"								Dud. Solenoid Failure on Rack. Ejection Charge Exploded on Impact.
K-149	"	"	"	10.3	200	11.5	11.8	170	180	C	Damaged Panel at Opening. Fast Burning Candle.
P-166	MK-45	1000	400	10.4	200	11.0	12.5	199	208	5.9	Unstable ±30°-±45° Oscillation.
P-167	"	"	"	10.0	200	11.2	11.4	204	218	C	Very Unstable - Small Amount of Comp. Lost at Bolt Explosion.
K-188	Flat Circ.	"	"	10.4	200	11.5	11.5	225	234	6.5	More Stable. Lost Drogue Chute.
K-189	"	"	"	9.6	205	9.7	10.0	212	212	C	Stable. Lost Drogue Chute.
K-190	"	"	"	9.2	205	10.0	10.0	177	200	8.7	Stable. Shroud Lines Entangled. May have been Reason For Early Collapse. Faster Descent Rate.
K-191	"	"	"	9.4	205	10.0	10.2	218	230	C	Unstable - Partial Collapse at 206 seconds Shroud Lines Burned.
K-192	"	"	"	10.5	200	11.0	12.3	213	224	6.7	Unstable - Lost Drogue Chute.
K-193	"	"	"	10.0	200	10.8	11.2	213	225	C	More Oscillation than MK 45 Lost Drogue Chute.

* C IS CAMERA COVERAGE AND NO RADAR RECORD MADE OF FLARE.

EXPERIMENTAL PARACHUTE TESTS

APPENDIX A

FLARE NO	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE)*	REMARKS
P-168	MK-45	1000	300	9.8	205	10.2	11.2	183	210	7.1	Unstable - Explosive Bolt Failed. Shroud Lines Burned Causing Early Collapse.
P-169	"	"	"	9.2	205	10.0	10.0	220	235	C	Stable First Half of Burning Time Then Very Unstable.
K-194	Flat Circ.	"	"	10.0	200	10.2	11.5	225	225	6.9	Stable First Half of Burning Time Then Very Unstable.
K-195	"	"	"	9.8	205	10.4	10.4	209	217	C	Very Unstable Last Half of Burning Time.
K-196	"	"	"	11.2	210	11.5	12.6	213	223	7.2	Stable All The Way.
K-197	"	"	"	10.0	200	11.0	10.4	185	209	C	Early Explosive Bolt. Finished Burning On Ground.
K-198	"	"	"	9.2	205	9.8	10.5	208	215	8.2	Unstable - Shroud Lines Fouled Up.
K-199	"	"	"	10.4	200	10.6	11.4	208	216	C	More Stable - Partial Collapse at 185 Sec.
P-170	MK-45	500	200	6.2	195	6.7	7.6	226	236		Stable first Half of Burning TIME. Then Very Unstable. No Radar Coverage.
P-171	"	"	"	6.0	195	7.0	7.2	217	231	C	Stable First Half of Burning Time Then Very Unstable.
K-202	FLAT CIRC.	500	"	7.5	195	8.0	8.3	208	213	8.4	Stable First Half of Burning Time Then Unstable.
K-203	"	"	"	7.2	195	8.0	8.2	202	214	C	Stable First Half of Burning Time Then Unstable.
K-204	"	"	"	7.1	195	7.3	8.5	206	224	6.9	Stable First Half of Burning Time Then Unstable.
K-205	"	"	"	7.0	195	7.6	8.2	203	215	C	Stable, Shroud Lines Seemed Fouled Up.
P-172	MK-45	"	"	7.6	195	8.0	8.4	200	215	8.6	Stable First Half of Burning Time Then Unstable.
P-173	"	"	"	6.4	195	7.5	7.2	211	223	C	Stable First Half of Burning Time Then Unstable.
K-206	Flat Circ.	"	"	6.2	195	7.7	7.5	210	224	7.8	Unstable.

* C IS CAMERA COVERAGE AND NO RADAR RECORD MADE OF FLARE

EXPERIMENTAL PARACHUTE TESTS

APPENDIX A

FLARE NO	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE) *	REMARKS
K-207	Flat Circ.	500	200	7.0	195					C	End Cap Ejected But the Chute & Candle Did Not Eject from the Outer Tube.
K-208	"	"	"	3.4	215	3.6	4.2	217	225	8.2	Unstable. Fast Ejection Delay.
K-209	"	"	"		195	6.9	7.2	207	207	C	Unstable. No Record of Ejection Delay.
K-210	"	"	"	6.4	195	8.0	7.3	199	216	8.8	Stable First Half of Burning Time Then Unstable.
K-211	"	"	"	6.0	195	7.3	6.8	210	221	C	Stable First Half Only. Chute Never Fully Collapsed After Explosive Bolt Fired.
P-174	MK-45	"	"	6.9	195	7.7	8.2		226	10.5	Stable. Dropped too low therefore the Candle Hit the Ground Burning.
P-175	"	"	"	6.0	195	7.9	7.2	222	234	C	Unstable.
K-212	Flat Circ	"	350	7.4	210	7.4	8.5	210	219	8.8	Unstable.
K-213	"	"	"	6.4	215	7.4	7.0	147	193	C	Stable. 4 Ft. Tear in Chute along Bottom Hem Seam. Early Exp. Bolt. Finished Burning on Ground.
K-214	"	"	400	7.9	210	8.0	9.2	201	210	7.7	Unstable.
K-215	"	"	"	7.0	215	7.5	7.8	210	210	C	Unstable.
K-216	"	"	450								Lanyard Broke Approx. 1 Foot from Fuse Dud. Never Pulled Pin out of Striker.
K-217	"	"	"	6.2	230	7.0	8.0	202	202	C	Stable First Half of Burning Time Then Unstable.
P-176	MK-45	"	200	7.2	195	7.9	8.5	219	220	7.0	Unstable.
P-177	"	"	"	7.0	195	7.2	7.4	192	214	C	Unstable. Lost Large Amount of Comp. When Exp. Bolt Fired.
K-220	CROSS	500	"	6.5	195	7.3	8.0		204	5.7	Stable. Looked Like Burned Shroud Lines. Early Collapse.
K-221	"	"	"	6.6	195	7.3	7.4	201	216	C	Stable. Upward last 20 seconds before Exp. Bolt Fired.

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EXPERIMENTAL PARACHUTE TESTS

APPENDIX A

FLARE NO	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE)*	REMARKS
K-222	CROSS	500	200	7.2	195	7.6	8.5	216	223	2.9	Very Stable. Upward into Smoke Before Exp. Bolt Fired.
K-223	"	"	"	6.8	195	7.1	7.2	215	222	C	Stable.
P-178	MK-45	"	"	6.9	195	7.0	8.0	197	211	6.8	Unstable. Lost Comp. as Explosive Bolt Fired
P-179	"	"	"	7.2	195	7.5	7.8	220	230	C	Unstable.
K-224	CROSS	"	"	7.0	195	7.5	8.1	221	227	3.6	Stable. Upward into Smoke Last 20 Sec. Before Collapse.
K-225	"	"	"	6.0	195	6.9	6.8	216	218	C	Stable. Upward into smoke last 20 Sec. before collapse.
K-226	"	"	400	NO RECORD	230	6.8	NO RECORD	177	208	5.1	Stable. Early Collapse, Streamer, then Burned Shroud Lines.
K-227	"	"	"							C	Lanyard Pulled out of Nico-Press Dud. Sleeve Did not Pull Pin.
K-228	"	"	390	NO RECORD	215	7.8	NO RECORD	204	225	3.7	Stable. Chute Dumped Before Exp. Bolt Fired May Have Burned Shroud Lines.
K-229	"	"	"	5.6	230	6.8	6.2	146	206	C	Stable. Early Collapse. May have Burned Shroud Lines. Lost Comp. During Burning Time
P-180	MK-45	"	200	7.2	195	7.7	8.4	203	220	7.7	Unstable. 30° to 45° Oscillation.
P-181	"	"	"	6.0	195	6.7	6.8	222	231	C	Unstable. 30° to 45° Oscillation.
K-230	CROSS	"	"	6.0	195	6.3	7.6	211	225	3.5	Very Stable. Slow Descent Rate. Up into Smoke at 180 seconds.
K-231	"	"	"	6.0	195	6.2	6.6	215	223	C	Very Stable. Slow Descent Rate. Upward into Smoke last 30 seconds.
K-232	"	"	"	6.5	195	7.4	7.4	193	215	3.9	Stable. Slow Descent Rate.
K-233	"	"	"	6.9	195	7.0	7.8	178	216	C	Stable. Streamer at 178 seconds. Before Exp. Bolt Fired.
K-234	"	"	"	7.5	195	8.2	8.8	198	213	2.5	Stable. Slow Descent Rate. Upward last 20 seconds before Exp. Bolt Fired.
K-235	"	"	"	7.0	195	8.0	7.6	175	222	C	Stable. Streamer at 175 seconds. Hit Ground Burning.
P-182	MK-45	1000	300	9.0	205	10.0	10.4	191	222	7.4	Unstable. Streamer-Dropped Comp. & Hit Ground Burning.

* C IS CAMERA COVERAGE AND NO RADAR RECORD MADE OF FLARE

APPENDIX A.

[illegible] PARACHUTE TESTS

FLARE NO	TYPE CHUTE	FUZE SETTING	AIRCRAFT SPEED (KIAS)	LAUNCH TO CANDLE EJECTION	PARACHUTE DEPLOYMENT VELOCITY	LAUNCH TO IGNITION	LAUNCH TO CHUTE OPENING	IGNITION TO CHUTE DUMP	TOTAL BURNING TIME (SEC)	RATE OF DESCENT (AVE)*	REMARKS
P-183	MK-45	1000	300	9.6	205	10.0	10.4	209	225	C	Unstable.
K-236	CROSS	"	"	NO RECORD	205	10.4	No RECORD	185	220	3.6	Stable. Streamer at 185 seconds. Finished Burning on Ground.
K-237	"	"	"	9.0	205	9.8	10.0	206	220	C	Stable. Lost 10 seconds of Comp. at End of Burning Time.
K-238	"	"	"	9.0	205	9.5	10.6	218	225	4.5	Stable.
K-239	"	"	"	9.6	205	9.8	10.4	162	207	C	Stable. Streamer at 162 Sec. Exp. Bolt at 183 Sec. Burned out on ground
K-240	"	"	"	10.1	205	10.3	11.1	202	216	3.9	Stable. Did not Rise into Smoke at End of Burning Time. Good even rate of descent.
K-241	"	"	"	9.2	205	10.3	10.0	181	212	C	Stable. Streamer at 181 Seconds. Exp. Bolt Fired on Ground.
P-184	MK-45	"	430								DUD. Failed to Set Fuze.
P-185	"	"	"	9.6	205	10.6	10.4	215	215	C	Unstable.
P-186	"	"	"	10.2	205	10.4	11.4	208	222	4.5	Unstable. Lost Some comp. during burning Time.
P-187	"	"	"	9.2	205	9.9	10.0	221	229	C	Unstable.
K-244	CROSS	500	425	8.8	210	9.8	10.1	205	205	4.9	Stable. Upward Last 20 seconds. Flame Hidden By own smoke.
K-245	"	"	"	NO RECORD	205	10.4	NO RECORD	193	207	C	Stable. Lost Some comp. during last of Burning Time
K-242	"	"	"	7.0	215	7.2	8.0	209	218	5.1	Stable. Upward into own smoke last 10 seconds of Burning Time
K-243	"	"	"	5.3	230	7.0	6.6	207	216	C	Stable. Streamer at 207 Seconds. Exp. Bolt Fired on Ground.
K-246	"	"	450	5.0	230	7.5	8.3	208	218	4.7	Stable.
K-247	"	"	"	7.2	215	8.0	8.0	197	211	C	Stable.

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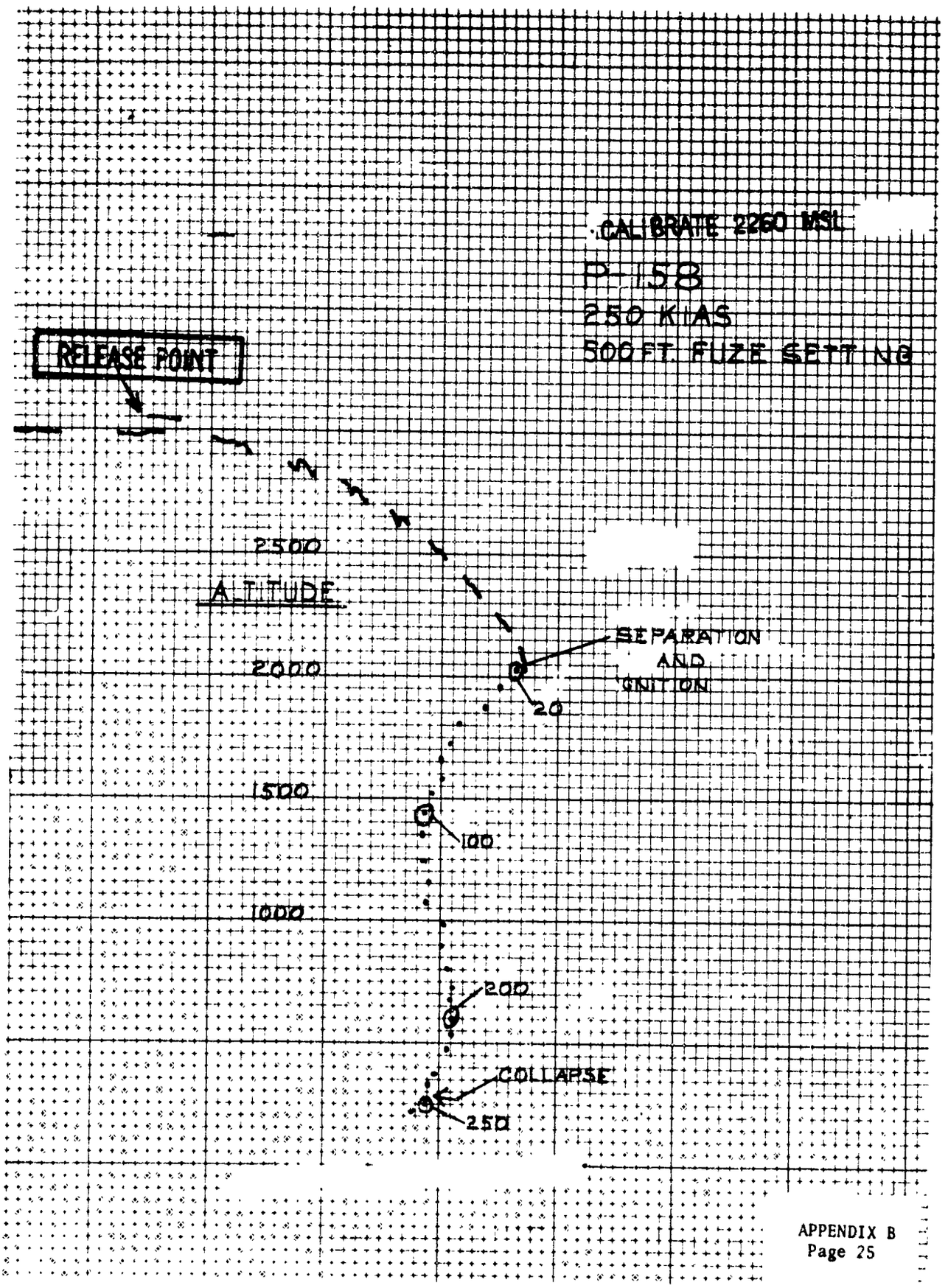
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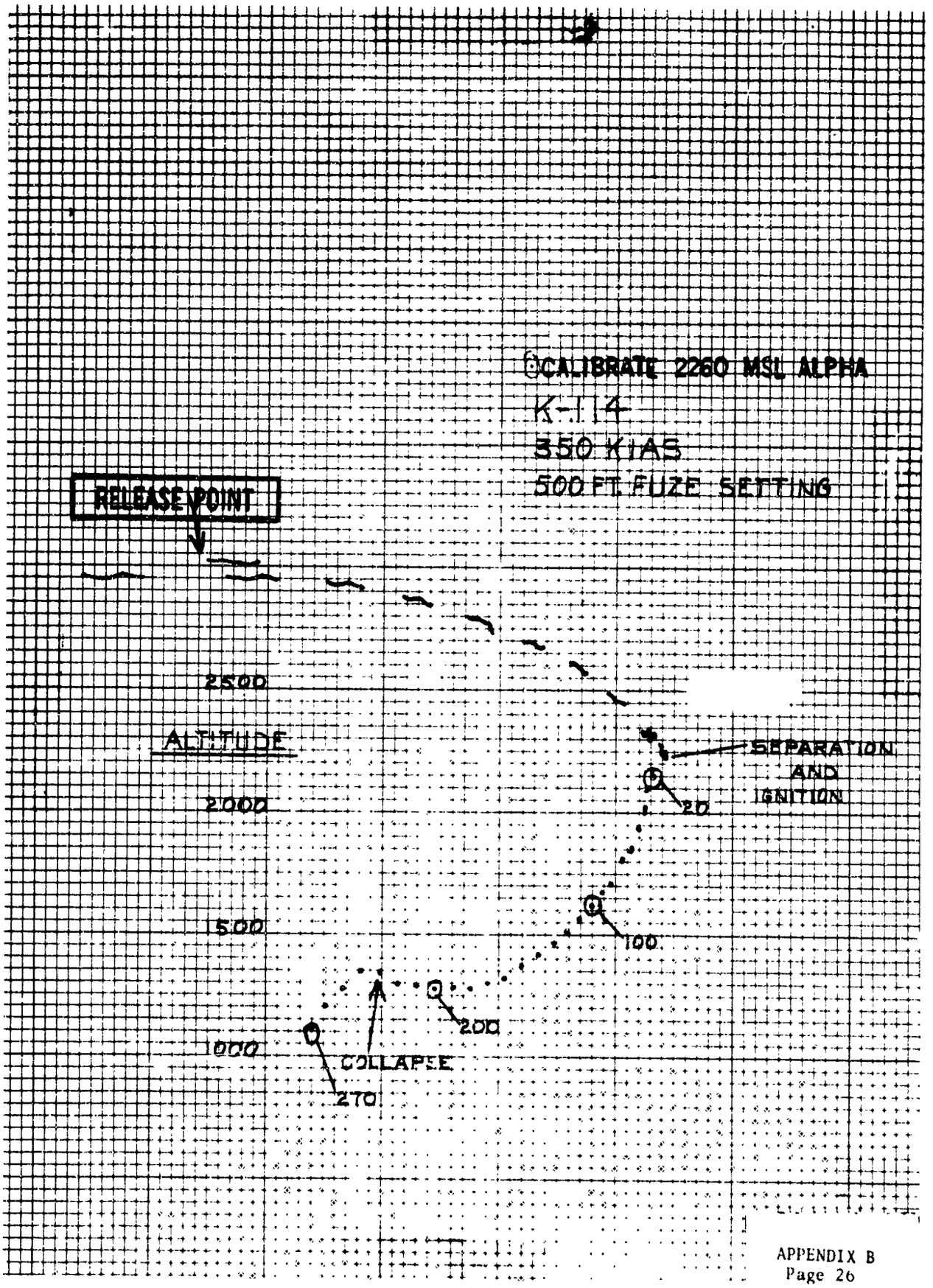
1500
1000
SEPARATION AND IGNITION
20
100
200
COLLAPSE
250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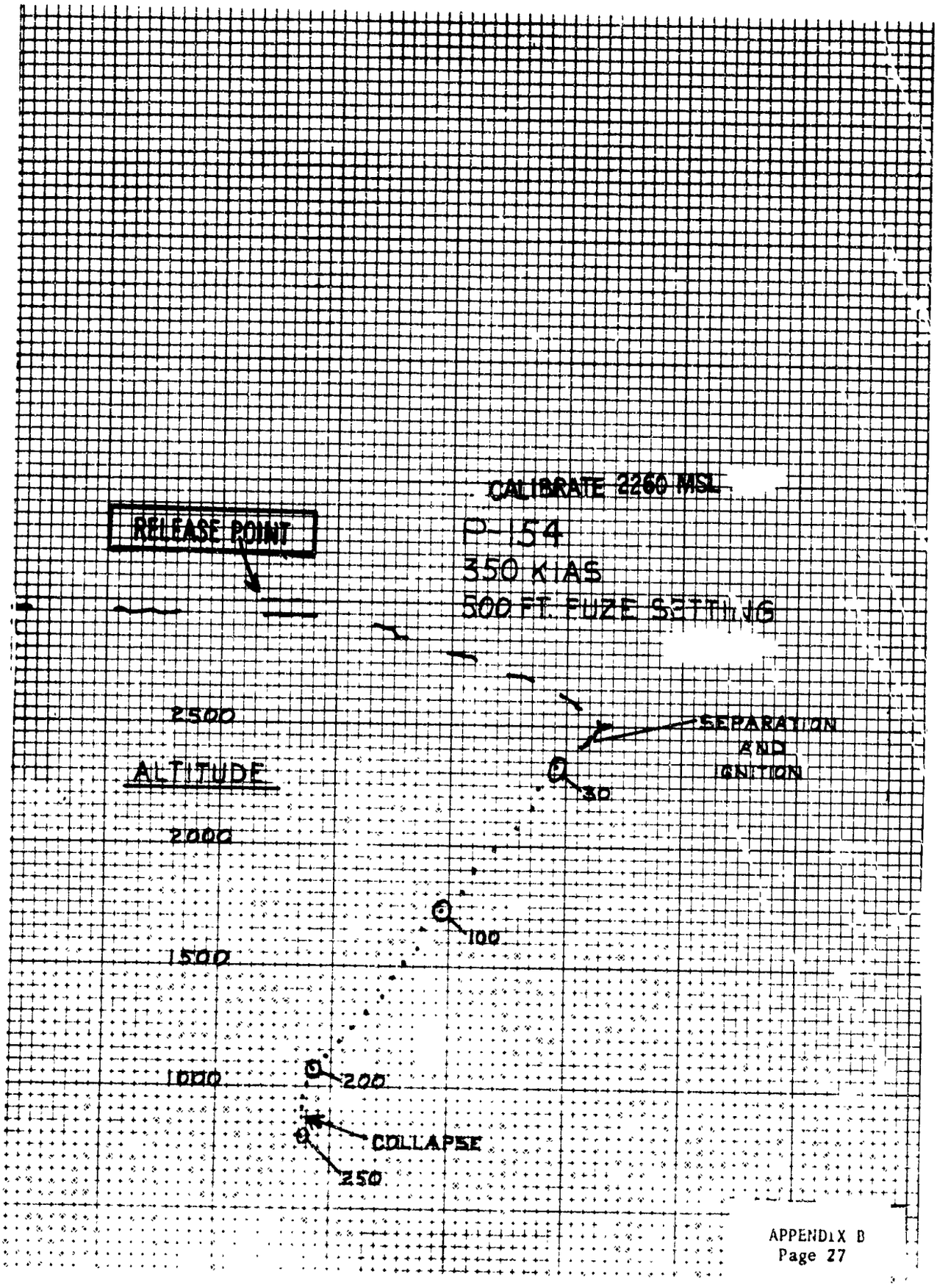
100
200
COLLAPSE
270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P-154
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ALTITUDE
SEPARATION AND IGNITION
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100
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1000
200
COLLAPSE
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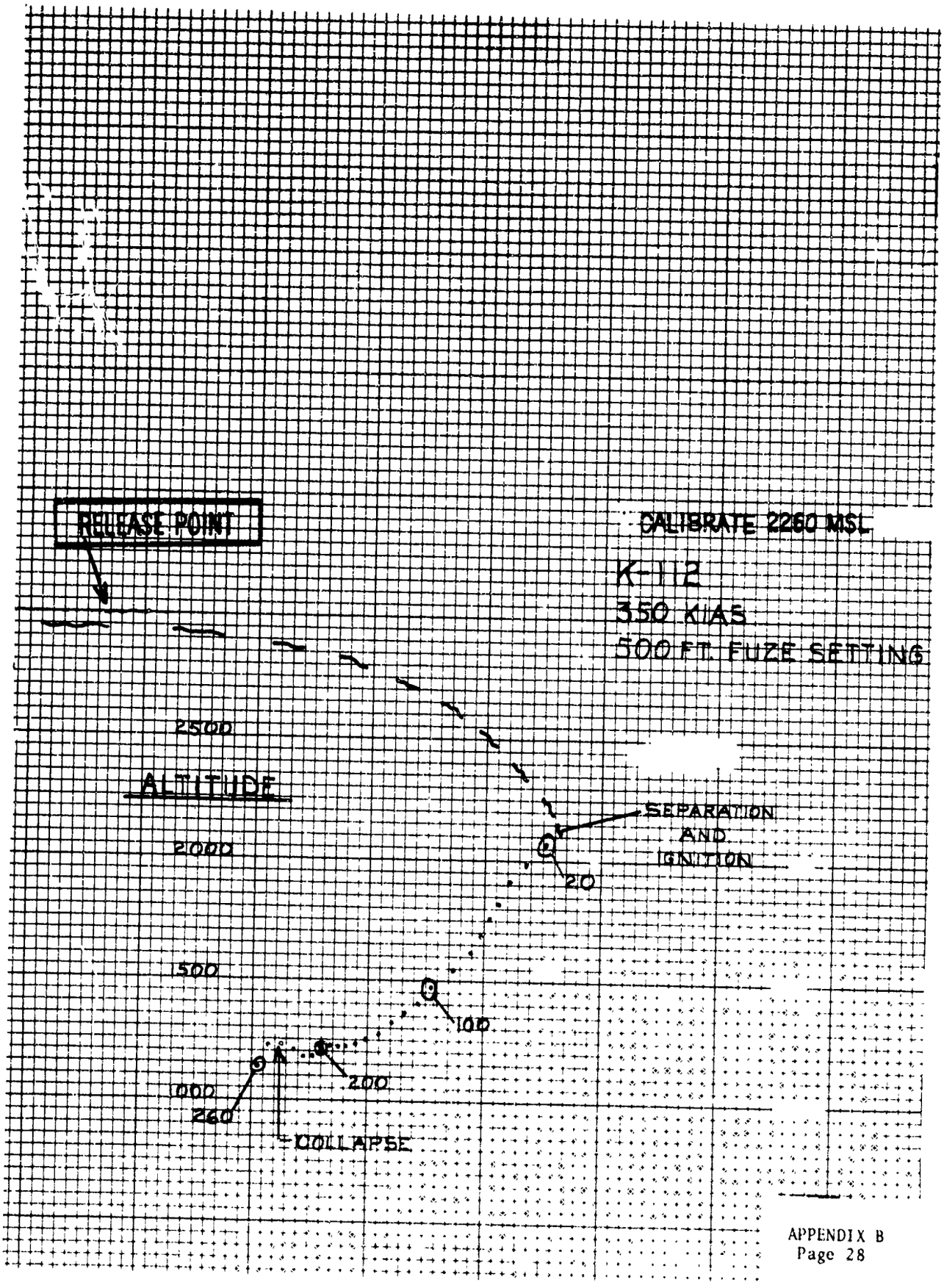
RELEASE POINT
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AND
IGNITION
20
100
200
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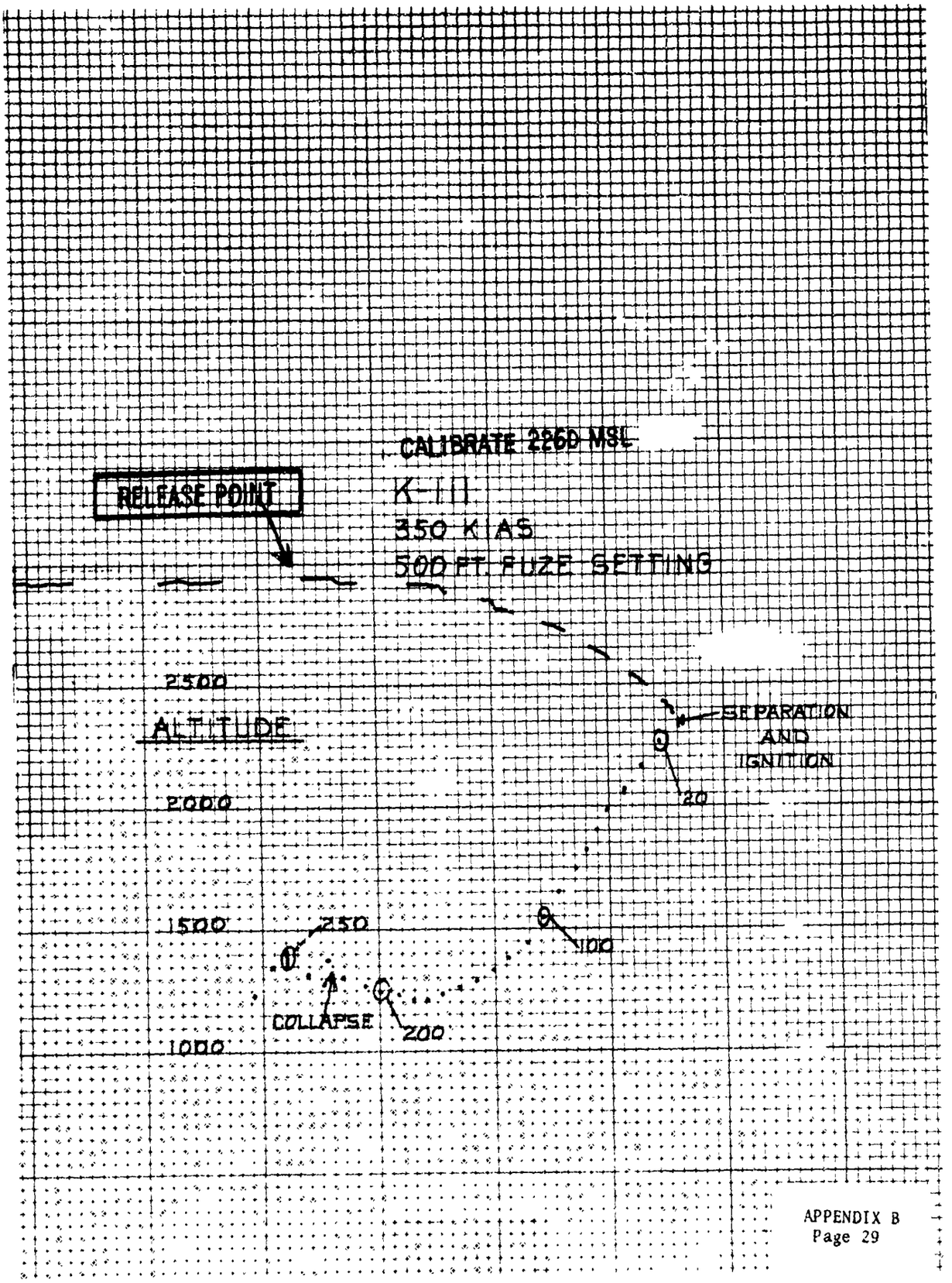
COLLAPSE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RELEASE POINT
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SEPARATION
AND
IGNITION
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COLLAPSE
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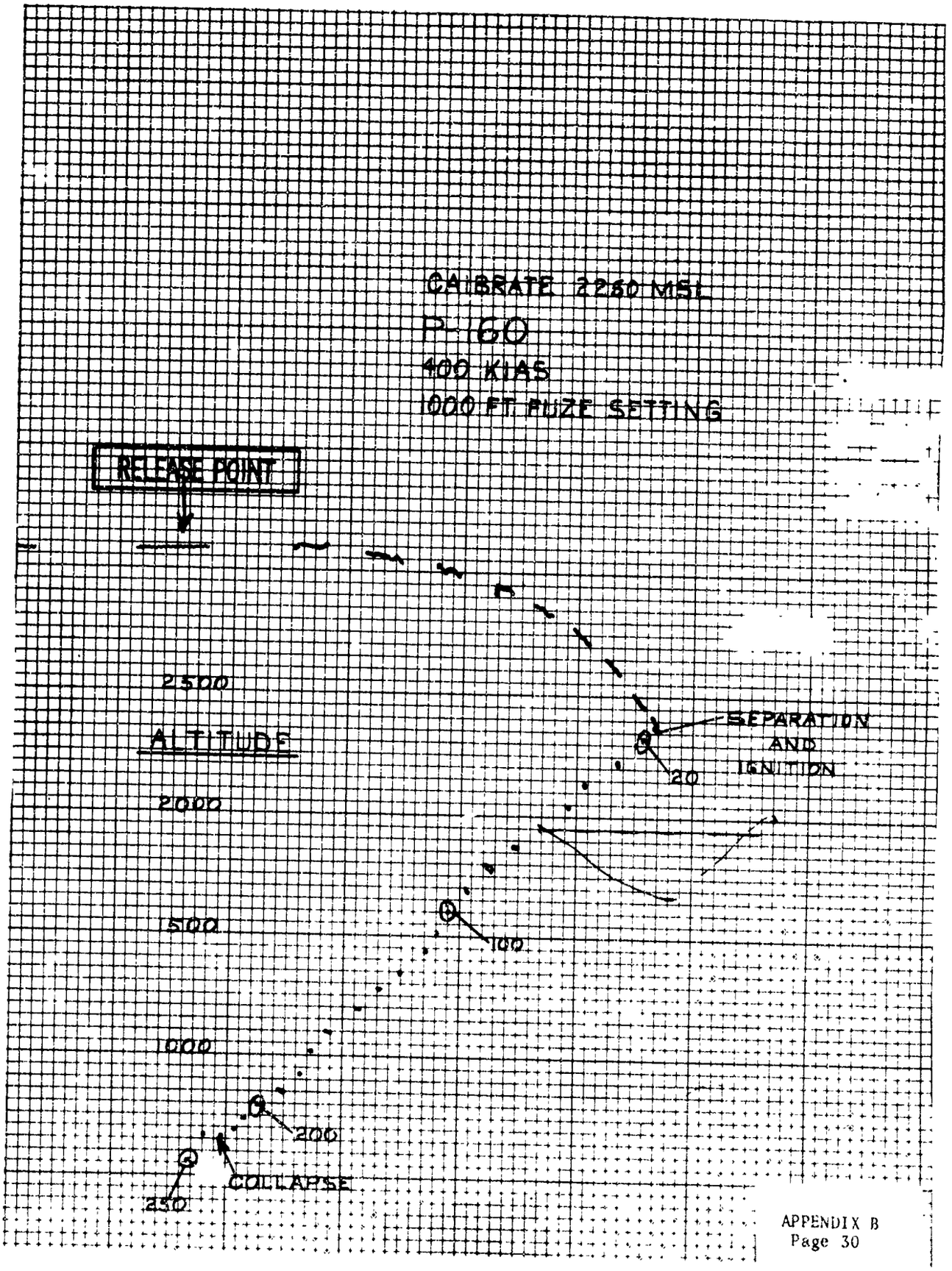
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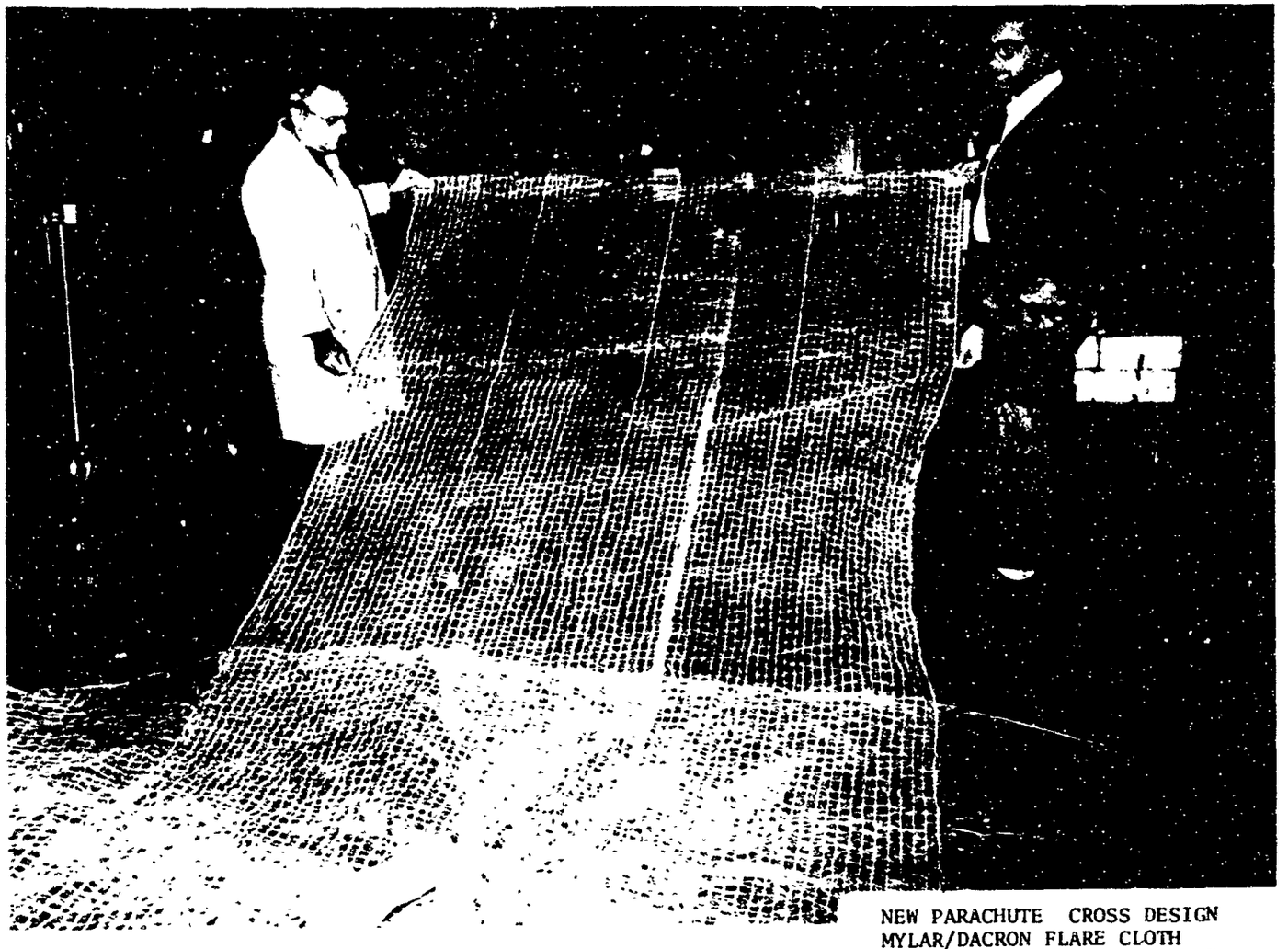
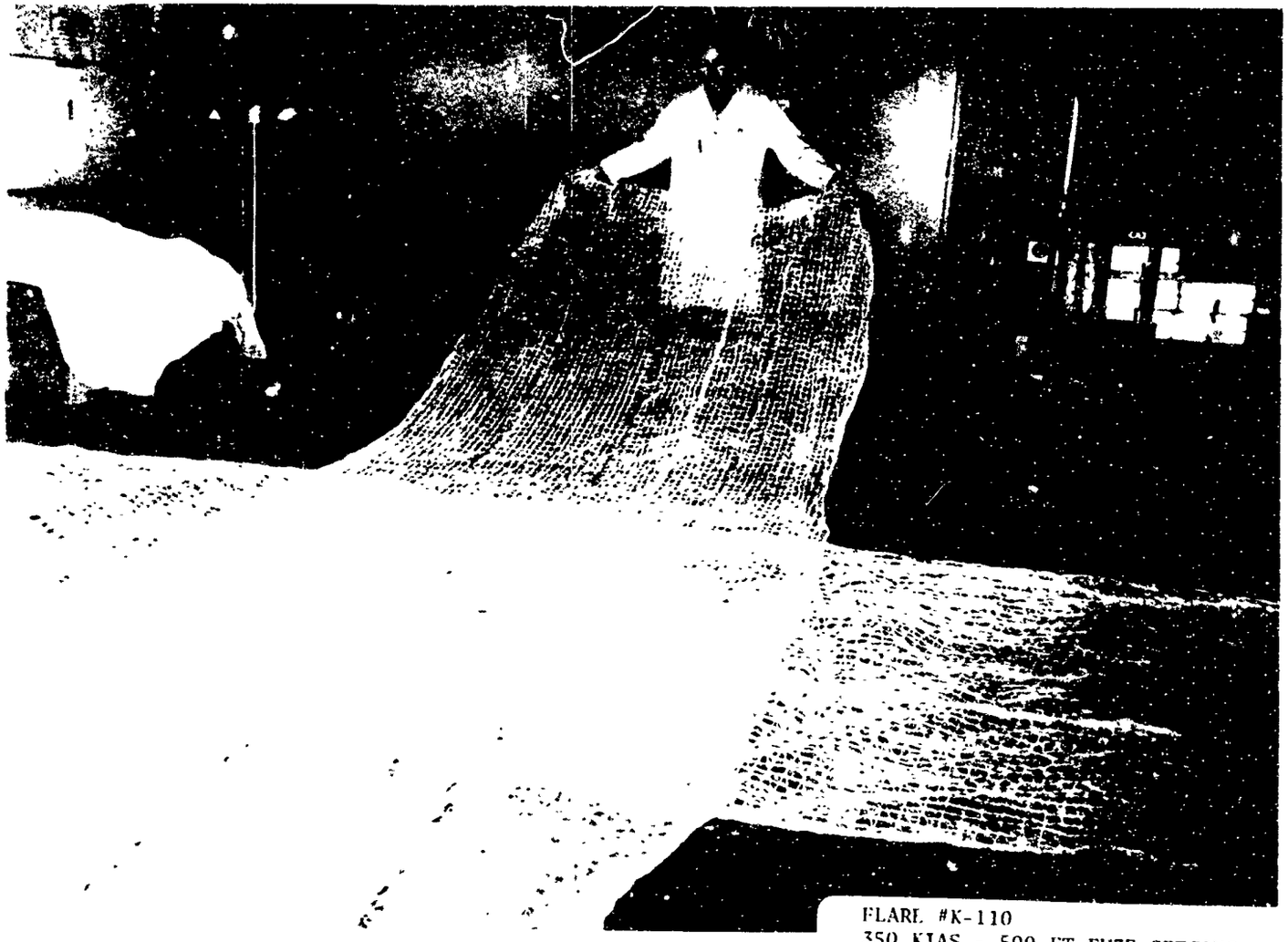
COLLAPSE



NEW PARACHUTE CROSS DESIGN
MYLAR/DACRON FLARE CLOTH
SHOWS ONE GORE OF NEW CHUTE

Appendix C



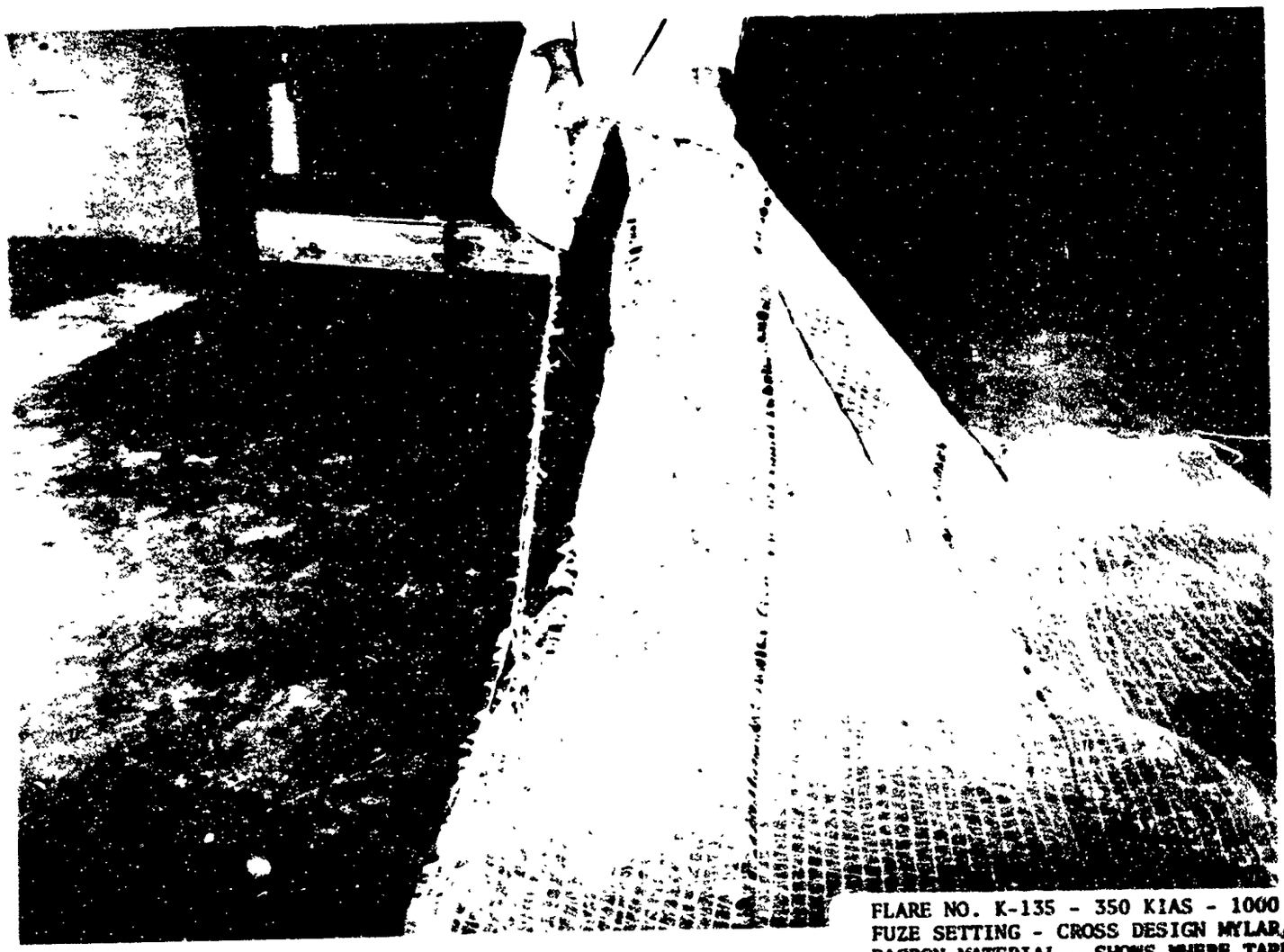
FLARE #K-110
350 KIAS - 500 FT FUZE SETTING
CROSS DESIGN WITH MYLAR/DACRON FLARE CLOTH
DEPLOYED AT 220 FT/SEC

FLARE No. K-110 - 350 KIAS
500 FT. FUZE SETTING
CROSS DESIGN WITH MYLAR/DACRON FLARE CLOTH
DEPLOYED AT 220 FT/SEC

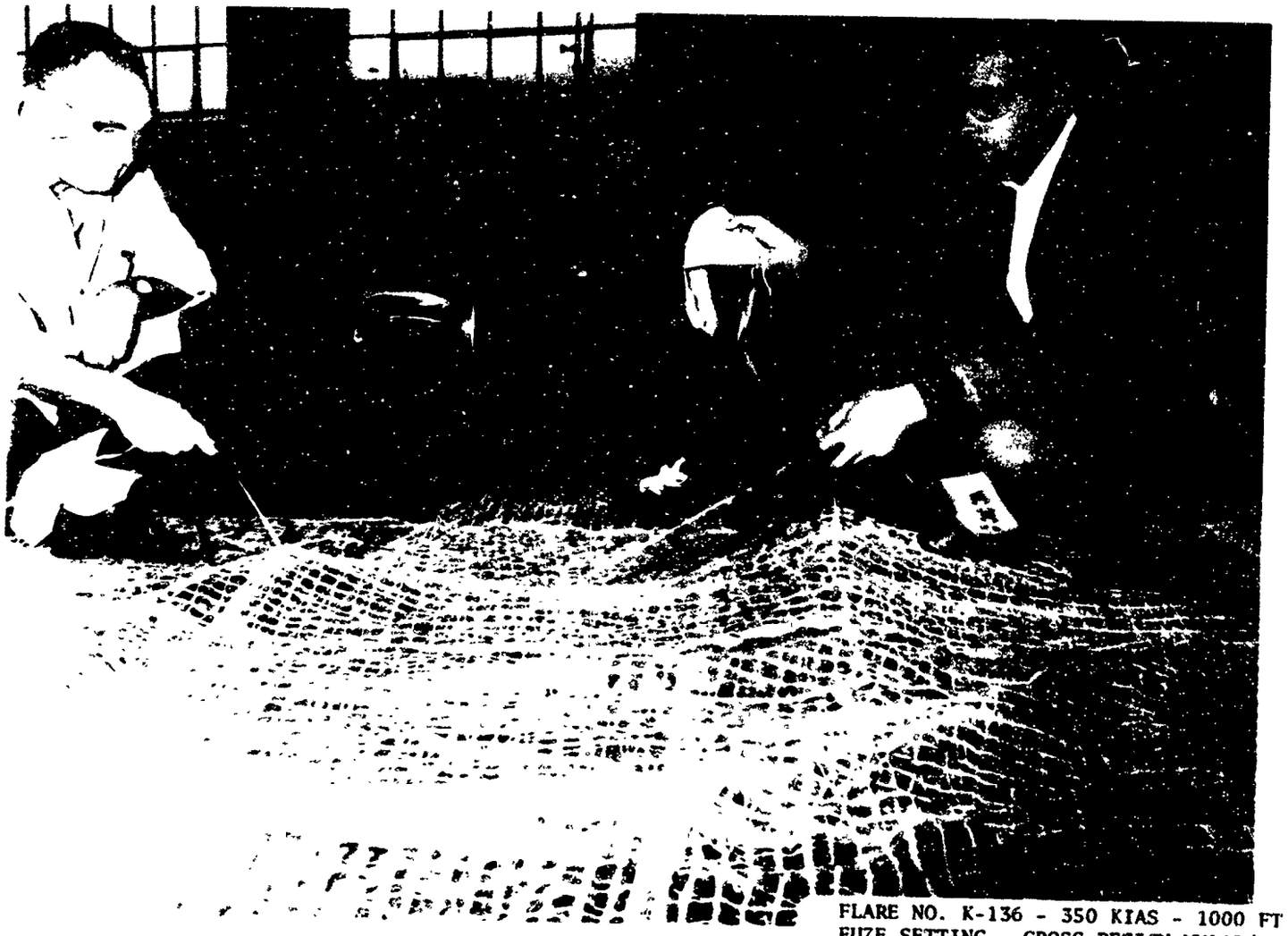
FLARE NO. K-118 - 300 KIAS
500 FT. FUZE SETTING
CROSS DESIGN MYLAR/DACRON FLARE CLOTH
SHOWS DAMAGE WHERE DEPLOYMENT BAG
IS ATTACHED - DEPLOYED AT 220 FT/SEC

FLARE NO. K-133 - 400 KIAS - 1000 FT. FUZE SETTING - CROSS DESIGN MYLAR/ DACRON FLARE CLOTH - SHOWS TAPE PULLED LOOSE & OTHER TAPE DAMAGE TO ONE GORE. DEPLOYED AT 210 FT/SEC

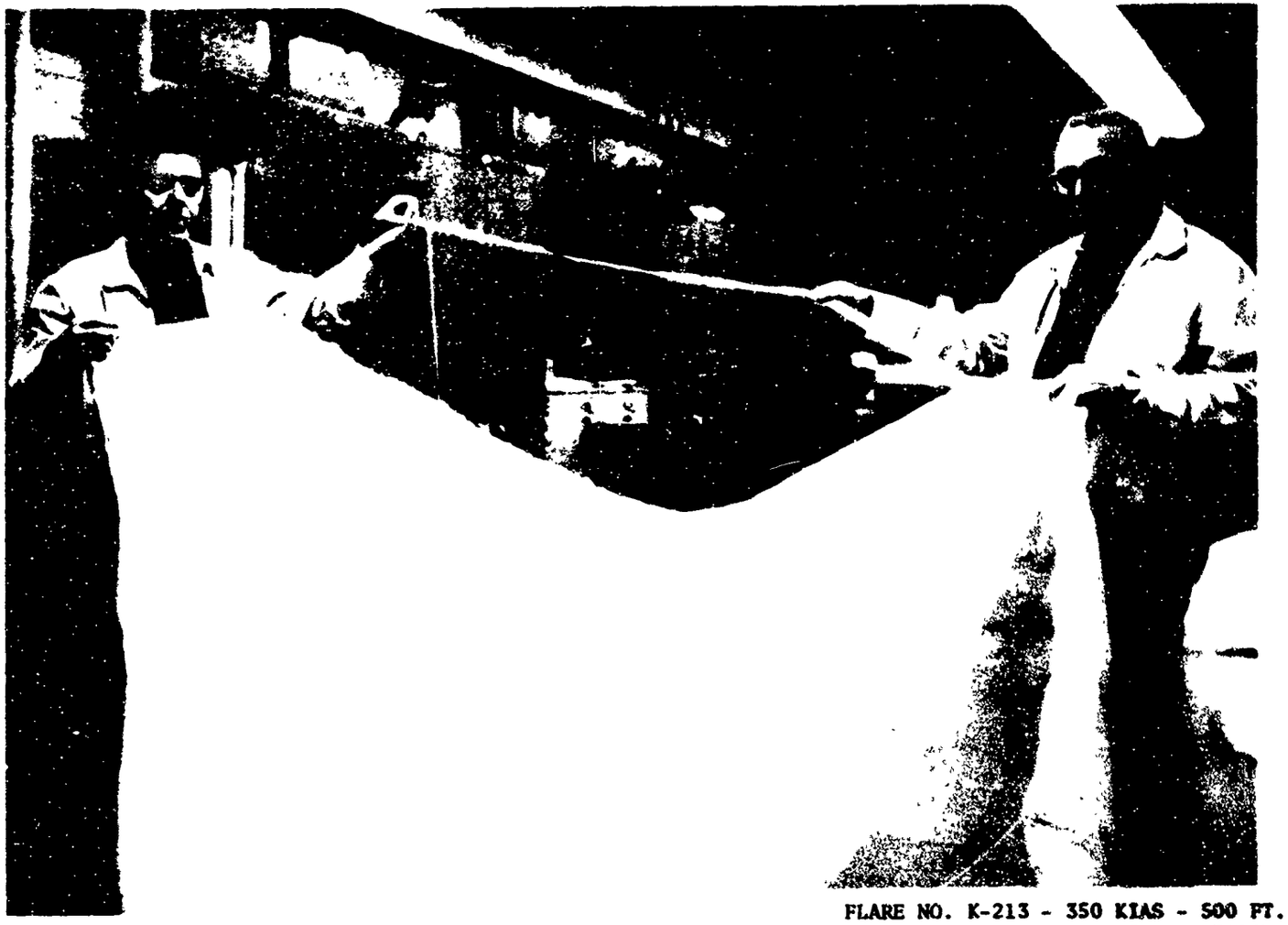
FLARE NO. K-135 - 350 KIAS - 1000 FT
FUZE SETTING - CROSS DESIGN MYLAR/
DACRON FLARE CLOTH - SHOWS DAMAGE WHERE
DEPLOYMENT BAG IS ATTACHED -
DEPLOYED AT 205 FT/SEC.



FLARE NO. K-135 - 350 KIAS - 1000 FT.
FUZE SETTING - CROSS DESIGN MYLAR/
DACRON MATERIAL - SHOWS WHERE TAPE
TORE LOOSE ON ONE GORE -
DEPLOYED AT 205 FT/SEC



FLARE NO. K-136 - 350 KIAS - 1000 FT FUZE SETTING - CROSS DESIGN MYLAR/ DACRON FLARE CLOTH - SHOWS DAMAGE TO DEPLOYMENT BAG AREA. DEPLOYED AT 205 FT/SEC



FLARE NO. K-213 - 350 KIAS - 500 FT.
FUZE SETTING - FLAT CIRCULAR DESIGN
CEREX FLARE CLOTH - SHOWS DAMAGE TO
ONE GORE -
DEPLOYED AT 215 FT/SEC

FLARE NO. K-245 - 425 KIAS - 500 FT
FUZE SETTING - CROSS DESIGN CEREX FLARE
CLOTH - SHOWS CLOSE UP OF SLIGHT DAMAGE
TO ONE GORE. DEPLOYED AT 205 FT/SEC

FLARE NO. K-247 - 450 KIAS - 505 FT
FUZE SETTING - CROSS DESIGN CHREX FLARE
CLOTH - SHOWS DAMAGE TO ONE GORE -
DEPLOYED AT 215 FT/SEC

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11 SUPPLEMENTARY NOTES	12 SPONSORING MILITARY ACTIVITY

13 ABSTRACT

This report presents the results of MK 45 Aircraft Parachute Flare Development Flight Tests (experimental parachutes and parachute materials) conducted at Naval Weapons Center, China Lake, California, 12 November 1969 through 11 December 1969. The basis for choice of chutes and materials for these tests was derived[1] from RDTR #163. Data obtained from these flight tests indicate the cross type parachute using Cerex Cloth (.85 oz/sqyd) to exhibit the most advantageous characteristics for incorporation to the MK 45 APF system. The data also indicates that a strength problem exists when the same canopy material (Cerex) is used on the present MK 45 circular chute. A third system utilizing a Cross parachute with a Mylar laminate cloth was evaluated. This chute also had cloth failures at parachute snatch loading forces.

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
1. Mylar/Dacron Material 2. Parachute Flares 3. Cerex Material 4. MK 45 APF 5. Cross Type Parachute						